Novel lightweight CFRP bogie frame

ERCI Innovation Awards 2020

Prof. Dr.-Ing. Andreas Ulbricht
Dipl.-Ing. Florian Zeidler
Dipl.-Ing. Sepp Renner

CG Rail GmbH

September 23rd, 2020
Overview CG Rail GmbH

Lightweight design as a key success factor for rail vehicles in the future

• **Limited axle loads** vs additional passenger comfort systems, increased crashworthiness, multi-system capability for international operation, ...

• **Energy and resource efficiency** to reduce the environmental impact of railway systems

• **Reduction of operating costs** (energy, maintenance) by “intelligent” lightweight systems

*Lightweight CFRP car body shell developed by CG Rail*

*Lightweight CFRP bogie frame*
Overview CG Rail GmbH

One-stop lightweight solutions for rolling stock industry

• **Coverage of the whole development chain** from design and simulation up to manufacturing and test of prototypes **with local innovation partners**

• Execution of **research and development projects on innovative lightweight structures** in multi-material design:
  - Component and mould design including ply-books (CATIA® - CPD-module), Product data management (PDM) software 3DExperience®
  - Experts for joining technologies (European Adhesive Engineers, Special Welding Engineer)
  - Implicit and explicit Finite-Element Simulation (FEM): Hyperworks, Ansys, Abaqus, LS Dyna
  - Experts for RAMS-analysis (DIN EN 50126), fire safety (DIN EN 45545),......
  - Project management (IPMA®-certified managers)

• Special knowledge in development and manufacturing of **ultra-large and thick-walled composite structures** (Special focus: pultrusion)

• **Material characterization** (stiffness and strength) on own testing machines

Lightweight CFRP bogie frame developed by CG Rail

Ultra-large pultrusion machine at CG Rail and cross sections of pultruded CFRP beams
Novel CFRP bogie frame

Overview of world’s first full CFRP bogie frame in innovative differential design

- **Nearly 50 % mass reduction** compared to the reference bogie frame made of steel
- Innovative *differential design approach* with four primary CFRP-components
- *Development of automated and reproducible* manufacturing technologies for the primary CFRP components – Realization of an innovative manufacturing equipment for digital production with high efficiency according to *Industry 4.0*
- **Successful** test over **12 million load cycles** *(Test according to EN 13749)*
- Development time of only **15 months**
- **Achieved TRL level: 5 to 6**
- 2nd generation will be in **real operation in 2021**
Novel CFRP bogie frame

CNC-controlled braiding process for textile preform of CFRP longitudinal beam

- **Prefoming** for longitudinal beams by automated braiding process in a first step, followed by infiltration with resin within a closed metallic mould (*Resin Transfer Moulding*)
- Braiding allows the integration of fibre-optic sensors (FOS) for structural health monitoring and condition based maintenance
- Very good reproducibility proved by 3-point bending test of all 10 produced CFRP longitudinal beams
Tests under static and cyclic loading (according to standard EN 13749)

• All tests under static as well as cyclic loading have been successfully finished!
• Successful test over 12 million load cycles with a load level of up to 160 %
  (Load level during normal operation 100 %)
Acknowledgments

- Team of CG Rail GmbH

- University of Excellence „TU Dresden“:
  - Institute of Lightweight Engineering and Polymer Technology (ILK)
  - Institute of Railway Vehicles and Railway Technology
  - ...

- Leichtbau-Zentrum Sachsen GmbH (LZS)

- thyssenkrupp Carbon Components GmbH (tkcc)

- IMA GmbH Dresden (IMA)

- and many more....
Thank you for your attention!